Cosmetic outcome and complications of enucleation in retinoblastoma patients

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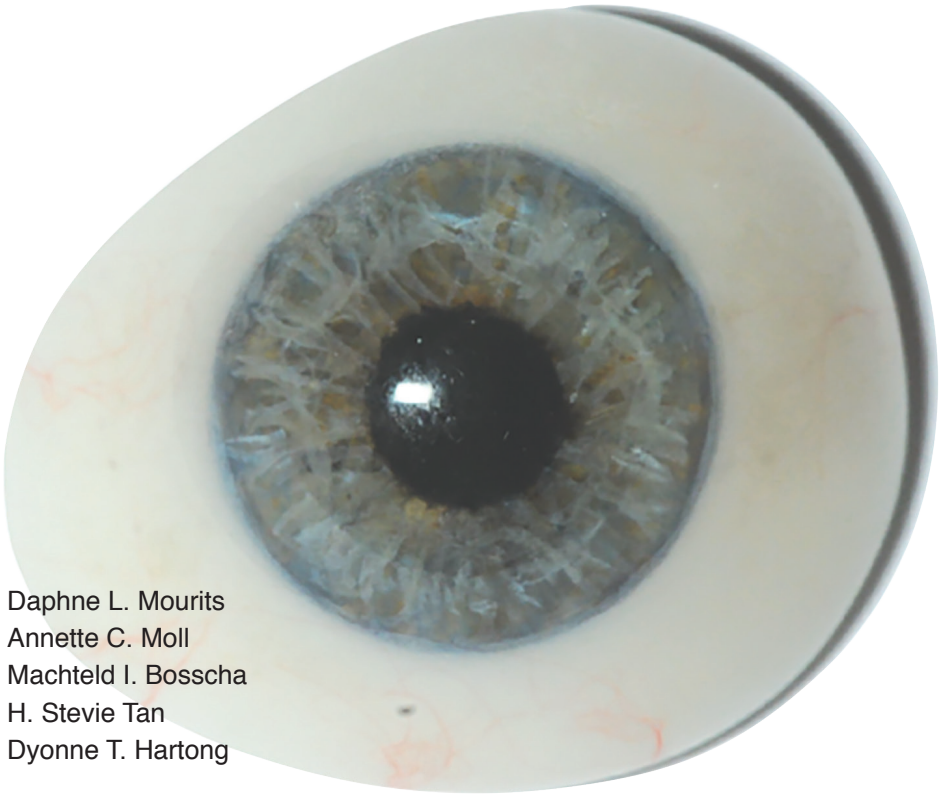
Chapter 2

Orbital implants in retinoblastoma patients: 23 years of experience and a review of the literature



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Abstract

Purpose

To evaluate complications of different types of orbital implants following enucleation for retinoblastoma.

Methods

We performed a retrospective chart study of all patients that underwent enucleation as treatment of retinoblastoma between April 1991 and June 2013. Events of implant exposure, extrusion (defined as a complete loss of the implant, or a major exposure that could not be closed) and socket abnormalities were analyzed for association with implant type and influence of additional external beam radiation therapy (EBRT) and/or chemotherapy.

Results

A total of 224 enucleations in 216 patients (8 bilateral) were identified. Mean age at surgery was 1.9 (median 1.5) years. Of the 219 included enucleated eyes, 20 were not replaced by a primary implant and 18 were replaced by an Allen implant. Scleral wrapped hydroxyapatite (HA) and acrylic implants (polymethylmethacrylate) were inserted in respectively 79 and 102 cases. In the total population, 29 treatment or implant specific events (13.2%) were registered. Main complications were implant exposure n = 10 (4.6%) and extrusion n = 6 (2.7%). The acrylic / sclera group had less exposures or extrusions (5 of 102, 4.9%) compared to the HA / sclera group (10 of 79, 12.7%), although this difference did not quite reach statistical significance (p = 0.06). Additional treatment (chemotherapy and/or EBRT for the fellow eye) was administered in 78 cases (35.8%). The overall complication rate in the entire study population was significantly higher (16.7% versus 5.7%) in the group exposed to additional therapy (OR 3.3; 95% CI 1.30-8.36 p = 0.008). This negative effect of additional therapy was also significant in the combined acrylic / HA group (OR 2.9; 95% CI 0.97-8.46 p = 0.048).

Conclusion

Our results suggest a favourable outcome for the acrylic implant compared to the HA implant. Additional treatment with chemotherapy and/or EBRT is associated with an increased risk of complications.

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Introduction

Retinoblastoma is a rare malignant eye tumour arising from the retina in children. The tumour typically occurs in the first five years of life during retinal development and maturation. The incidence is estimated between 1 in 15.000 and 20.000 live births, accounting for approximately 10-15 new cases per year in the Netherlands.[1]

A wide variety of globe saving modalities are available in the treatment of intraocular retinoblastoma: cryotherapy; transpupillary thermo therapy; intravenous chemotherapy (chemoreduction) with consolidation therapy; selective intra-arterial chemotherapy (SIAC); intravitreous chemotherapy; subconjunctival/ subtenon chemotherapy; plaque radiotherapy (brachytherapy), external beam radiation therapy (EBRT); or a combination of these.[2–11] Enucleation, however, remains an effective and often lifesaving treatment option especially in unilateral advanced intraocular retinoblastoma, which is seen most commonly.

Implant types and wrapping materials used in enucleation surgery have evolved over time. The orbital implant is inserted for the purpose of compensating orbital volume loss and as a substitute of an internal orbital growth stimulus, both resulting in improvement of cosmetic appearance.[12–14] The implant potentially facilitates movement of the prosthesis[12] and may reduce the risk of a contracted socket, which is especially seen in patients in whom enucleation is combined with EBRT.[15] Wrappings that envelop the solid and often rough surfaced implant devices are used for muscle attachment and prevention of conjunctival abrasion. Complications after enucleation such as socket contraction, migration, exposure or extrusion of the implant, require revision surgery. This additional procedure can have a negative effect on the cosmetic outcome, such as contraction of the socket and fornices, decreased motility due to fibrosis and scarring and could have a negative influence on prosthesis fitting.

The present study aims to evaluate the complications that occurred during our 23 years of experience in enucleation procedures for retinoblastoma. Results are compared with the reviewed literature.

Methods

Patient population

A review of medical records revealed 216 patients with retinoblastoma treated with enucleation (8 bilateral). In all cases, the diagnosis was histopathologically confirmed.

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The present retrospective study was performed in accordance with the recommendations of the local ethics committee of the VUmc.

Study design

The authors reviewed the medical records of a total of 224 consecutive enucleations for retinoblastoma performed between April 1991 and June 2013 at the Dutch Retinoblastoma Center (VU University medical center, Amsterdam), where all retinoblastoma patients in the Netherlands are diagnosed, treated and followed. Data obtained included patients' date of birth, sex, age at diagnosis, heredity, laterality, other retinoblastoma treatment(s), enucleation technique, implant type and size, and wrapping material, as well as per- and postoperative complications, and duration of follow-up. A minimal postoperative follow-up of one year was set as requirement for inclusion. Patients who underwent secondary enucleation were also included in the study. Patients who primarily did not receive an implant, but got an implant at a later stage were not included, nor were cases of implant replacement. Patients with a long interval (7 months and 4 years) between enucleation and subsequent administration of chemotherapy (for orbital recurrence or other malignancy, n = 2) were considered as 'enucleation without additional treatment'. We assumed that chemotherapy only influences the healing process of the socket. The primary outcome was occurrence of implant exposure or extrusion during follow-up. Exposure was defined as a disruption of the conjunctival layer, with or without disruption of the scleral wrapping. Extrusion was defined as a complete loss of the implant, or a major exposure that could not be closed. Secondary outcomes were all other reported complications, i.e. socket contraction, tilting of the implant and total ptosis.

Statistical analysis

The Pearson chi-square test was computed to analyze outcome in the two main implant groups (hydroxyapatite versus acrylic implant). Odds ratio's were calculated to describe possible risk factors for complications.

Review of the literature

PubMed was searched from inception to 7 January 2014. The following terms (including synonyms and closely related words) were used as index terms or free-text words: 'eye enucleation' or 'orbital implants' and 'retinoblastomas' and 'cohort studies' and not 'case reports'.

The search results were reviewed for relevance. Included were all retrospective and prospective studies conducted in the past 30 years reporting enucleation for retinoblastoma with a follow-up > 1 year. Excluded were papers in languages

other than Dutch, German, English, French and Italian. A total of 393 articles were reviewed by title and abstract; of these, 54 were selected. In addition, related articles and relevant references of the selected articles were scrutinized. The main reasons for exclusion of the full articles were lack of data on one of our outcome parameters (exposure and extrusion), and missing information about the type of implant used. We also excluded studies that focused on other aspects of enucleation for retinoblastoma (e.g. pathology).

Ultimately, 17 studies were included and compared with our results.

Results

Between April 1991 and June 2013, a total of 275 children (118 females, 157 males) were diagnosed with retinoblastoma in our institution. In this period, 224 eyes of 216 consecutive patients were enucleated (209 primary and 15 secondary enucleations). Mean age at surgery was 1.9 (median 1.5) years. The number of enucleated patients accounted for 78.6% of all patients diagnosed with retinoblastoma. Five patients were excluded: three died within one year, one moved abroad directly after surgery and one had exposure considered not implant-related. The patient characteristics are presented in Table 1.

Recurrence and second primary malignancies

In one patient purulent discharge and exposure of the hydroxyapatite (HA) implant announced a local recurrence of retinoblastoma 7 months postenucleation. The patient was secondarily treated with local resection, chemotherapy, EBRT and implant replacement. This patient is still disease-free at 10.5 years of follow-up. As mentioned above this case is excluded since the exposure is not considered implant-related.

Two patients developed a second primary malignancy (both osteosarcoma, one in the fellow orbit, one located in the femur); both are still alive after extensive treatment.

Surgical materials and techniques

Over time different implant methods were used: no implant (n = 20), Allen implant (n = 18), scleral wrapped hydroxyapatite (n = 79), or acrylic implant (n = 102), see Figure 1 and Table 2.

All enucleations are performed under general anesthesia. The basics of the procedure have remained consistent over time. We start by performing perilimbal dissection of conjunctiva and tenon, release of the oblique muscles, isolation of

Table 1. Patient characteristics

Patients N = 211 (219 cases)	N	Percent (%)
Sex		
Male	120	56.9
Female	91	43.1
Retinoblastoma laterality		
Unilateral	139	65.9
Bilateral	72	34.1
Side of enucleation		
Right	96	45.5
Left	107	50.7
Additional therapy		
Both eyes	8	3.8
Chemotherapy	40	18.9
EBRT	25	11.8
*Both**	13	6.1
Total	78	36.8

* One patient received intra-arterial chemotherapy and EBRT, in all other cases chemotherapy refers to systemic intravenous chemotherapy.

the four recti muscles (using vicryl sutures for later reattachment) and division of the optic nerve. In case of implant insertion the implant size is estimated using a dummy sizer. In case of Allen implants, the recti muscles are pulled through four openings and sutured in a central knot. With the hydroxyapatite implants, the muscles are pulled through a pre-cut hole in the banked donor sclera that covers the implant. With use of acrylic implants the recti muscles are attached (para)centrally to the enveloping banked donor sclera. Tenon and conjunctiva are always closed in two separate layers using soluble vicryl sutures. Finally, topical corticosteroid / antibiotic ointment is administered. Minor adaptations are shown in Table 2. Postoperative treatment consists of a firm pressure bandage overnight and topical corticosteroid / antibiotic ointment b.i.d. for 7 days. Table 2 demonstrates the used techniques and implant material during enucleation.

Complications

Peroperative complications

A total of 21 peroperative complications were reported in 17 of the 219 surgeries (Table 3).

Postoperative complications

With respect to the primary outcome parameters, the implant-related events

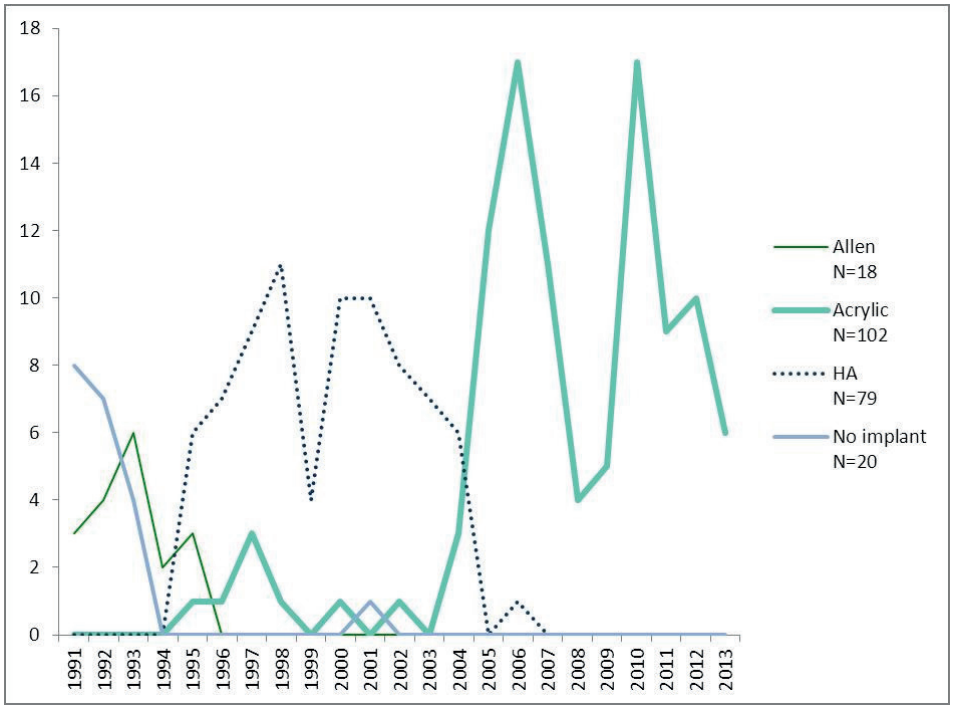

Figure 1. Type of implants inserted (N) per year.

Table 2. Used techniques and material in enucleation surgery implant types

Implant types	N	Percent of cases (%)	Period of specific implant use
No implant	20	9.1	1991 - 1994
Allen implant	18	8.2	1991 - 1996
HA implant wrapped in sclera	79	36.1	1994 - 2007
Acrylic implant wrapped in sclera	102	46.6	1994 - 2013

Techniques / instruments	N	Percent of cases (%)
Snare	197	90
Scissors	11	5
Lateral canthotomy	176	80.4
Illich conformer	93	42.5

Table 3. Per- and postoperative complications

Peroperative complications			
Type of complication			**Frequency of complication**
Snapped snare			10 (4.6%)
Slipped and retrieved muscle			5 (2.3%)
Need for canthotomy enlargement			2 (0.9%)
Short optic nerve stump			3 (1.4%)
Lack of availability of desired implant size			1 (0.5%)
Surgery related ptosis			2 (0.9%)
Postoperative complications			
Implant type	**N**	**Type of complication**	**Frequency of complication**
No implant	20	contraction	5 (25%)
Allen	18	tilting; extrusion	7 (38.9%); 1 (5.6%)
HA wrapped with donor sclera	79	exposure; extrusion	7 (8.9%); 3 (3.8%)
Acrylic wrapped with donor sclera	102	exposure; extrusion	3 (2.9%); 2 (2.0%)

'exposure' and 'extrusion' occurred in 16 of 199 (8%) patients with implant. Exposure was seen in 10 patients. Age at the time of enucleation in these cases was variable (range 0.3 to 106.5 months; mean 25 months) and not different from the cases without exposure or extrusion (range 0.6 to 125.1 months; mean 23.3 months). Also, implant sizes differed but there was no tendency for a higher or lower extrusion / exposure rate in small or large implants ($p = 0.26$ via linear-by-linear association). Table 3 summarizes the complications per implant type. Successful strategies for repair included conjunctival closure (n = 6), sometimes repeatedly, placement of a scleral patch (n = 1) and watchful waiting (n = 3). Extrusion occurred in 6 patients, requiring implant explantation with or without replacement of the implant. Comparing the two most frequently inserted implant types, HA implants versus acrylic implants, the acrylic / sclera group had the tendency to expose or extrude less (5 of 102, 4.9%) compared to the HA / sclera group (10 of 79, 12.7%), X^2 (1, n = 181) = 3,52, df 1, p = 0.06.

Regarding secondary outcome measures, 'socket contraction' was present only in patients who did not receive a primary implant. These patients were treated using socket reconstruction techniques such as fornix deepening sutures, mucosa- and fat transplants and bone pins to wear external prosthesis. However, the results of these repeated attempts were disappointing. 'Tilting' is a specific complication of the Allen implant occurring in 38.9% (7/18). It causes improper prosthetic fit, conjunctival prolapse, and a decrease of implant motility. In 4 cases the implant was replaced.

Table 4 summarizes the cases with complications. Of the patients with peroperative complications, two patients *(no. 23 and 29, Table 4)* suffered from persistent dysfunctioning of the levator muscle with a total ptosis as result. In one case the enucleation snare broke repeatedly with subsequent loss of the superior rectus muscle. The muscle was ultimately retrieved but this extra manipulation probably damaged the levator complex. In the other case the cause of the ptosis was unknown.

Additional treatment

In 78 cases (35.6%) additional chemotherapy and/or EBRT was administered for tumour treatment of the fellow eye or as a preventive measure if histopathological risk factors were present (Table 1). Table 5 shows the frequency of occurrence of the complications 'extrusion' and 'exposure' of the implant related to additional therapy.

Additional treatment in the total group (including the cases without implant) significantly increased the risk of exposure, extrusion and contraction: 16.7% (13 of 78) versus 5.7% (8 of 141) (OR 3.3; 95% CI 1.3-8.4 p = 0.008). Considering the two most frequently used implants (HA and acrylic implants) as one group, the patients that were exposed to chemotherapy and/or EBRT (n = 66) demonstrated a 13.6% complication rate versus 5.2% in the non-exposed n = 115 group, p = 0.048. Of the previously mentioned complications, 70% occurred within the first year after surgery and approximately 50% within the first 6 months. Three years was the longest duration until exposure.

Figure 2 shows the different complications in relation to implant type and additional treatment.

Review

Table 6 summarizes the 17 studies included for review[15–31] and the present study, each reporting the results of enucleation and implant insertion in children with retinoblastoma; the table shows the study period of these reports. A variety of implants (Figure 3), combined with different types of wrappings, was used. We did not encounter any randomized controlled trials.

Discussion

This retrospective study describes the surgical outcome of enucleation in retinoblastoma patients during the last 23 years in the Netherlands. It shows a shift over the years in the use of implant types. In the early years no implants were

Table 4. Complications summarized per patient

	Age at surgery (months)	Additional Therapy	Implant	Size	Complication	Elapsed time between enucleation and complication in months	Intervention
1	19.4	None	Allen	20	extrusion	0.5	Replacement with Allen 18, after second extrusion replacement with acrylic implant 16
2	37.6	Chemotherapy (post op for histopathological reason)	HA	18	extrusion and socket infection	7.3	Replacement with acrylic implant 16, recurrent extrusion and necrolysis wherefore explantation without new implant insertion
3	6.1	None	HA	16	extrusion	0.8	Explantation, without replacement
4	0.3	EBRT	HA	18	extrusion (after recurrent infections)	1.5	Explantation, without replacement and treated with antibiotics
5	45.4	Intra-arterial chemotherapy and EBRT (pre op)	Acrylic	20	extrusion	2.8	Explantation without replacement
6	23.2	None	Acrylic	18	extrusion	Directly post op	Resutured, scleral patch, replacement with acrylic implant 14, recurrent exposure
7	29	None	HA	18	exposure	4.2	Watchfull waiting
8	6.1	EBRT (post op)	HA	18	exposure and infection	2.5	Resutured + antibiotics
9	20.2	None	HA	18	exposure	6	Resutured
10	59.4	None	HA	18	exposure and fibrogranuloma	1	3 times resutured
11	1.4	Chemotherapy (post op for fellow eye)	HA	18	exposure	3.3	Watchful waiting + antibiotics
12	14	None	HA	18	exposure	6.4	Resutured
13	14.3	EBRT (pre op)	HA	16	chronic exposure	15	Repeatedly sutured + antibiotics
14	13.1	Chemotherapy (post op for histopathological reason)	Acrylic	18	exposure	2.5	Watchful waiting
15	4.3	Chemotherapy (post op for fellow eye)	Acrylic	18	exposure	36.4	Scleral patch + closure of tenon and conjunctiva
16	106.5	Chemotherapy (post op for histopathological reason)	Acrylic	20	exposure	NR	No intervention
17	16.8	None	Allen	16	tilting	42.4	Replacement with acrylic implant

Table 4. Continued

18	44	None	Allen	18	tilting	25	Reposition of Allen implant with sutures, finally replacement of Allen with acrylic implant 16
19	16.9	None	Allen	16	tilting	NR	Replacement with acrylic implant 20
20	29.4	None	Allen	18	tilting	NR	No intervention
21	12.1	None	Allen	16	tilting	71	NR
22	10.5	Chemotherapy and EBRT (post op for histopathological reason) and treatment fellow eye	Allen	16	tilting (and fellow orbit development of osteosarcoma)	3.3	No intervention (osteosarcoma treated with local resection, brachytherapy and chemotherapy)
23	18.1	None	Allen	16	tilting and ptosis directly postop primary procedure	48.5	Replacement with HA, 2 failed ptosis correction attempts
24	5.5	EBRT (pre op)	No		contracted socket	64	Socketreconstruction - twice
25	6.6	EBRT (post op for fellow eye)	No		contracted socket	48	Repeated reconstructions
26	9.5	EBRT (post op for fellow eye)	No		contracted socket	40.5	Reconstruction
27	7.3	EBRT (post op for fellow eye)	No		contracted socket (minor)	39	No intervention
28	6	None	No		contracted socket	215.5	Referred to orbital center
29	10.5	Chemotherapy (post op for histopathological reason)	Acrylic	18	ptosis	Directly post op	Potential correction at older age

NR = not reported
HA = hydroxyapatite
EBRT = external beam radiation therapy

inserted because of a general concern that recurrences could not be detected. This argument became less important with the advent of MRI. Since then, orbital implant insertion has become a routine procedure in our institution.

The first socket implants we used were Allen implants. Most complications were related to the design of the implant, where tilting resulted in a reversed effect of coupling to the ocular prosthesis. Since the early 1990s, the HA implant was frequently used.

Table 5. Relation between additional therapy and exposure and extrusion

Number of complications (exposure / extrusion) per implant group with and without additional therapy			
	Additional therapy	**No additional therapy**	***P***
Acrylic implant	4/45 8.9%	1/57 1.8%	p = 0.098
HA implant	5/21 23.8%	5/58 8.6%	p = 0.073
Acrylic & HA	9/66 13.6%	6/115 5.2%	p = 0.048
Allen	0/4 0	1/14 7.1%	p = 0.582

P-values given for comparison in outcome of additional or no additional treatment within an implant group.

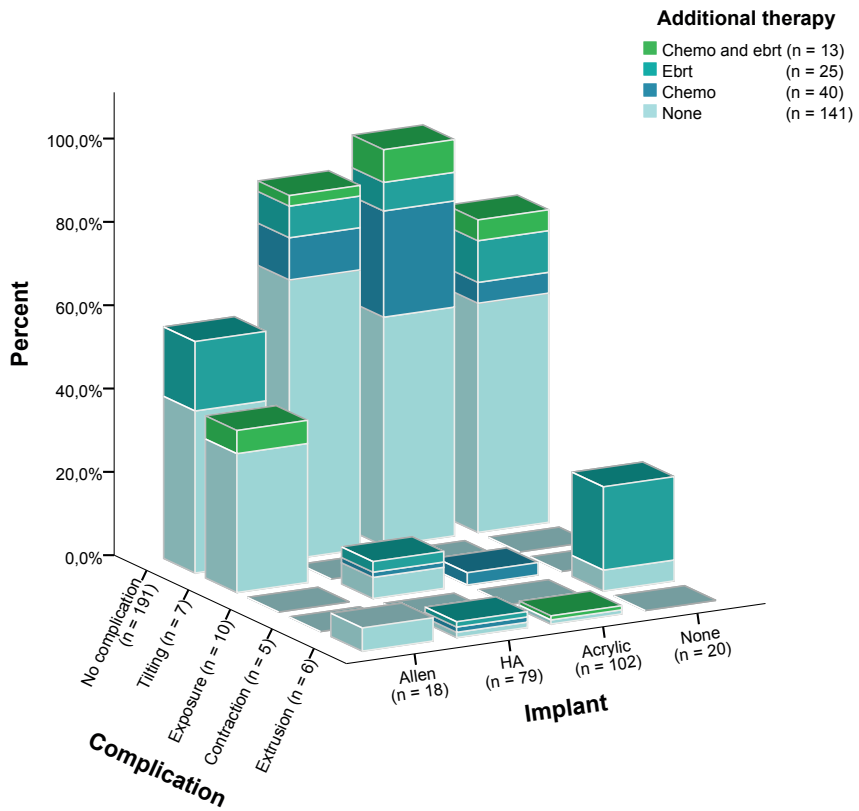

Figure 2. Complication representation per implant with account of additional therapy.

Table 6. Overview of studies reporting results of enucleation and implant insertion in children with retinoblastoma

First author of study and year of publication	Total number of studied sockets	Number of sockets of RB patients	Implants / wrappings	N	EBRT	Chemo	Exposure	Extrusion	Other complication	Elapsed time	Follow up	Study period
Christmas 2000	N = 123	RB = 106 (86)	Acrylic Silicone HA Iowa Universal Medpor / Sclera	9 5 103 1 1 1 109	11 (8.9)	NR	1 (0.8), *0*	0 (0)	Migr = 3 (2.4) Ptosis = 5 (4.1)	21 d – 96 m	36	1987-1998
O'Doherty 2005	N = 24	RB = 24 (100)	NR HA / NR	1 23	1 (4.2)	4 (1.7)	7 (29)	0 (0)	Ptosis = 1 (4.2) PESS = 1 (4.2)	17 d - > 6 m	4-170	1985-2003
Nolan 2003	N = 19	RB = 17 (89.5)	HA / VM HA / sclera	16 3	0 (0)	NR	7 (36.8)	0 (0)		12 d - 73,3 m	84.2 (2-168)	1987-2001
Overlapping patient population												
De Potter 1994*	N = 60	RB = 51 (85)	HA / sclera	60	3 (5)	NR	2 (3.3)	0	Conjunctival thinning = 5 (8.3)	4 m	19 (6-36)	1990-1993
Shields 1993*	N = 250	RB = 70 (28)	HA / sclera	250	6 (2.4)	NR	4 (1.6)	0	Conjunctival thinning = 8 (3.2) Peg extrusion = 2 (of 31 pegs)	6.5 m	23 (6-42)	1990-1992
Lumbroso 2000	N = 105	RB = 101 (96.2)	HA / sclera HA / Goretex HA / VM HA / PTFE HA / NR	17 5 39 38 6	19 (18)	NR	16 (15)	2 (1.9)	Other conjunctival problems = 5 (4.8)	NR	22 (median)	1991-1998

Table 6. Continued

Wang 2007	N = 47	RB = 34 (72.3)	HA / donor sclera HA / lyodura HA / porcine sclera HA / VM Medpor HA / VM and anterior scleral patch Bioceramic / VM and ant. scleral patch	9 4 3 5 4 10 12	0	2 (4,3)	7 (14.9), *1 (50)*	0		4.3 m	24-228	1992-2006
Lee 2000	N = 108	RB = 108 (100)	Castroviejo Medpor Acrylic Acrylic / Mersilene HA / VM	10 13 50 17 18	27 (25)	48 (44.4)	30 (27.8), *18 (24)*	0	Excessive discharge = 12 (11.1)	1 - 630 days	3-55	1993-1997
Karcioglu 1998**	N = 37	RB = 37 (100)	Medpor	37	11	NR	8 (21.6), *4 (36.4)*	0	Migr = 2 (2.7) Contr = 5 (13.5)	18.9 m	23.45 (1-48)	1993-1997
Iordanidou 2004	N = 36	RB = 21 (58.3)	Medpor / anterior wrap sclera: autologous homologous	6 30	1 (2.8)	13 (36.1)	1 (2.8), *0*	0		54 m	44	1998-2002
Kim 2004/2005*	N = 77	RB = 77 (100)	Medpor Medpor / free orbital fat graft	39 38	0	39 (50.6)	13 (16.9) (*all in Medpor without fat graft group)*	0		15 m	22.7	1998-2003
Heimann 2005	N = 32	RB = 32 (100)	Silicone / PU HA HA / silicone Medpor	13 13 1 5	0	12 (37.5)	7 (22)	0		12.5 m	7 -70.8	1998-2003
Overlapping patient population												
Shildkrot 2011*	N = 135	RB = 128 (95)	HA / polymere coated HA / dermal allograft HA / VM HA / retroauriculair muscle	85 31 16 3	21 (15.6)	69 (51.1)	28 (20.7), *21(23.3)*	3 (2.2), *2 (2.5)*	Contr = 6 (11.9) Migr = 1 (0.7)	0.9-60.7 m	43.2	1999-2009

Table 6. Continued

Kirzhner 2013*	N = 60	RB = 128 (95)	HA / polymere coated HA / dermal allograft HA / VM	43 17	0	0 *pt with add. therapy excluded*	7 (11.7)	1 (1.7)		1.4-43.3 m	43.2	1999-2009
Marx 2008	N = 10	RB = 10 (100)	QIPP	10	0	1 (10)	1 (10), *0*	0		15 m	36	2000-2005
Choi 2013	N = 44	RB = 44 (100)	Medpor SST	44	1 (2.3)	15 (34)	0	0	Conjunctival thinning = 3	NR	60.1	2004-2009
Present study 2015	N = 219	RB = 219 (100)	No implant Allen HA / sclera Acrylic / sclera	20 18 79 102	38 (17.4)	53 (24.2)	10 (5), *6 (8.6)*	6 (3) , *3 (4.3)*	Ptosis = 2 Tilting = 7 Contr = 5	0-215.5 m	117.5 (12-279)	1991-2014

Table legend:

N = total number of studied sockets
RB = number of sockets of retinoblastoma patients (% of total)
FU = mean (or range) follow-up time in months
EBRT = external beam radiation therapy, N (% of total)
Chemo = chemotherapy, N (% of total)
Exp = exposure of implant N (% of total implants), *n (%) within additional treatment group (if reported)*
Extr = extrusion of implant (% of total implants), *n (%) within additional treatment group (if reported)*
Contr = contracted socket
Migr = migration of implant
PESS = postenucleation socket syndrome
NR = not reported
Elapsed time = time interval between enucleation and complication (mean time and/or range expressed in months)
expressed in days (d) and months (m)

Implants:
HA = hydroxyapatite
Medpor = porous polyethylene
QIPP = quasi integrated porous polyethylene
Medpor SST= smooth surface tunnel Medpor

Wrappings:
PFTU = polytetrafluoroethylene
VM = vicryl mesh
PU = polyurethane

Studies reported in grey = studies with < 80 % sockets of RB patients

* overlapping patient population
** study period not reported, time estimated with means of publication date and maximum follow up time

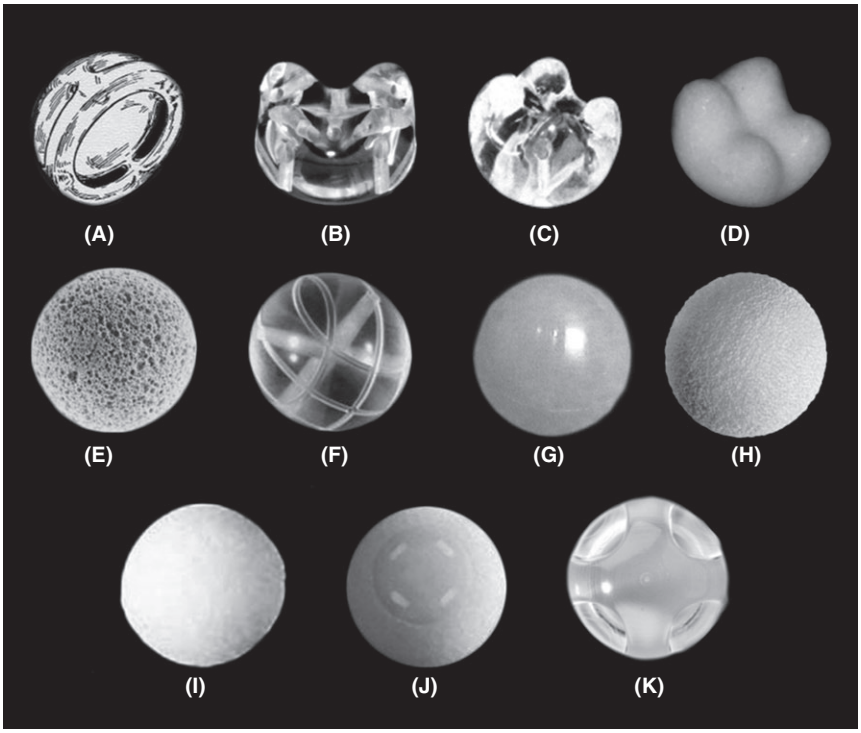

Figure 3. Images of the different mentioned implants.

A Allen (with courtesy of mr. M.O. Hughes: Hughes M. O., Joy, E. M., & Young, S. R. Lee Allen, Ocularist. Journal of OphthalmicProsthetics, 13–26.).
B Universal (with courtesy of mr. J.F. Durette, Oculo-Plastik, Inc).
C Iowa (with courtesy of dr. B. Spivey: Spivey, B. (1970). The Iowa enucleation implant. Trans AmAcad. Ophth. &Otol., 74.).
D Quasi-integrated porous polyethylene (QIPP) also Medpor Quad-Motility (with courtesy of mr. S. Lawrence, Stryker Craniomaxillofacial).
E Hydroxyapatite (with courtesy of mr. I. Weston, Network Medical Ltd.)
F Acrylic (with courtesy of dr. B Leatherbarrow and MedNet Technologies, Inc.).
G Silicone (with courtesy of mr. J.F. Durette, Oculo-Plastik, Inc.).
H Bioceramic (with courtesy of C. Pirson, FCI Ophthalmics).
I Medpor (with courtesy of mr. S. Lawrence, Stryker Craniomaxillofacial).
J Medpor SST-EZ (with courtesy of mr. S. Lawrence, Stryker Craniomaxillofacial).
K Castroviejo (with courtesy of mr. U. Farooq, TASBRO Surgical).

Our results show that the HA implant accounts for more exposures compared to the solid acrylic implant, although extrusion rates were low in both groups. Our findings are in line with the American Academy report by Custer et al.[32], which indicates that exposure rates of porous implants are similar to or higher than that reported for solid implants.

It was thought that the rough surface of the HA implant may induce tissue breakdown of the overlaying layers during eye movement. Also, orbital inflammatory responses to HA implants (characterized by a foreign body giant cell reaction) causing increased implant exposure have been documented.[33,34] In contrast, Christmas et al.[16] reported a significantly higher rate of complications with acrylic spheres than other implants. Differences in surgical technique could explain this discrepancy: part unwrapped, and part without muscle reattachment. Medpor (porous polyethylene), currently the second most popular porous implant, was used in seven of the reviewed studies. Like the porous HA, Medpor showed considerable exposure rates of 21.6%[24], 33%[26] and 61.5%[23] when implanted as a bare implant. As mentioned, porous implants require additional preventive measures to protect the conjunctiva from abrasion of the rough implant surface. Different measures for conjunctival protection are available: an implant may be wrapped by organic materials -which are either autologous (dermis-fat, fascia lata, temporalis fascia, posterior auricular muscle, rectus abdominis sheath) or allogenic (donor sclera, dura mater, bovine pericardium, dermis-fat)- or inorganic materials (polyglactin / vicryl mesh, polyglycolic acid mesh, polyurethane mesh, mersilene mesh, Gore-Tex), it may be anteriorly covered with a scleral patch or by insertion of a free orbital fat graft[22,25,26], the implant may also have a prefabricated covering (the polymer-coated hydroxyapatite implant[35]) or the implant itself can be adjusted with a smooth surface and predrilled tunnels for muscle attachment (Medpor SST[36]).

Promising results with the Medpor SST have been reported by Choi et al.[31] with no exposures in 44 retinoblastoma patients. The latter group is smaller than ours, but otherwise comparable with a substantial subgroup of patients (1/3) that also received additional therapy.

In our study both the acrylic and HA implants have a relative low complication rate. This might be attributed to the scleral wrapping technique that we use, which seems to reduce the risk of HA implant exposure[33,37–39] and enables muscle reattachment in both the HA and acrylic group.

A low complication rate using scleral wrapping is supported by the studies of De Potter et al.[19] and Christmas et al.[16] reporting exposure rates of 3.3% and 1.0%. These rates are lower compared to our study, but this could be due to a difference in populations; theirs seem to have a considerably lower additional intervention rate (see Table 6). No comparable follow-up study with acrylic / sclera combination as a treatment in retinoblastoma is available.

The reported studies with no wrapping or other wrapping materials, had exposure rates ranging from 0% to 36.8%.[15,17,18,21,22,28,29] Vicryl mesh wrapped implants had a higher complication rate compared to polymer-coated implants

(17.7% versus 9.3% exposure, respectively).[29] Some wrapping materials do worse than a bare implant with exposure of 53% using mersilene wrapping (compared to 8% without wrapping)[23], and 46% exposure with polyurethane wrapping compared to 5% with bare implant.[28] These reports seem to suggest that the type of wrapping plays an important role, where some wrapping materials with a potential inflammatory reaction seem unfavourable and increase exposure.[34]

In the present study no side-effects were noted from the use of banked donor sclera. The use of donor sclera was strongly discouraged after the report of an incident in the UK in 1997, where both corneas and scleras from a donor, subsequently confirmed to have had sporadic Creutzfeldt–Jakob disease, were transplanted.[40] Although no transmission of the disease has been reported thus far, this incident caused a shift to stricter donor selection criteria.[41]

With proper donor screening and protocolled tissue handling, scleral transmission risks are very low.[42,43]

In our study, exposure to additional therapy resulted in an increased risk of complications. An increased exposure risk with additional therapy is also seen comparing the studies of Shildkrot et al.[15] and Kirzhner et al.[29] (20.7% versus 11.7%), reporting the same patient cohort but in Kirzhner et al.[29] with exclusion of adjuvant treated patients. Lee et al.[23] also described an increased risk, however, without statistical significance. In contrast, no harmful effect of additional therapy to implants was reported by Iordanidou et al. (n = 36)[25] and Choi et al. (n = 44)[31], both using Medpor (SST) implants.

Overall rates of extrusion in the described studies were 0-2.2%. We reported 3% extrusion in the total studied implant population. We assume that a discrepancy exists in the definition of extrusion. Some authors reported the removal of the implant as management of exposure, whereas in our practice the necessity for explantation alone was reported as extrusion.

To our knowledge, this report is the largest study to evaluate the outcome of orbital implants after enucleation for the treatment of retinoblastoma in which two subgroups (HA / sclera versus acrylic / sclera) are highly comparable due to the use of the same protocols and almost identical surgical techniques. However, the time lines and, therefore, the follow-up duration differs between the two groups. In addition, other implant types have not been compared and the contribution of the artificial eye status (polished or not, improper fit) could not be tested in this retrospective study. This emphasizes the need for future prospective studies.

We conclude that primary orbital implant insertion following enucleation for retinoblastoma is safe and is associated with low rates of complications. Insertion of an implant prevents socket contraction and additional retinoblastoma treatment is associated with an increase in complication rate. Finally, our study results

suggest a favourable outcome for scleral wrapped acrylic implants compared to the HA implant.

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